RCA HF TRANSISTORS

For TV Applications

40235 40236
40237 40238
40239 40240

AS 200 Pelet

RCA-40235, 40236, 40237, 40238, 40239, and 40240 are high-frequency transistors of the silicon npn type, intended primarily for use in the tuner and if-amplifier circuits of vhf television receivers. These devices are also useful in communications equipment operating at frequencies up to approximately 260 Mc/s.

Types 40235, 40236, and 40237 are vhf types, for use as rf amplifier, mixer, and local oscillator respectively, in TV tuners covering Channels 2 through 13. Types 40238, 40239, and 40240 are for use in 45-Mc/s picture-if amplifiers.

These devices feature high gain-bandwidth products, very low feedback capacitance, and low cutoff currents, in addition to the high-temperature operation capability of silicon.

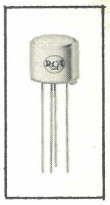
RCA-40235 through 40240 utilize a hermetically sealed metal case which is electrically isolated from the transistor electrodes. The case is provided with a fourth lead, which may be connected to an rf ground point to minimize collector-to-base interlead capacitance and coupling to other circuit components.

Absolute Maximum Ratings:

	40235 40236 40237 40238 40239 40240	
COLLECTOR-TO-BASE VOLTAGE, V_{CBO}	35 max.	V
COLLECTOR-TO-BASE VOLTAGE, V_{CBV} (V_{EB} = 1 V)	35 max.	V
EMITTER-TO-BASE VOLTAGE, V_{EBO}	3 max.	V
COLLECTOR CURRENT, I_C	50 max.	mA
TRANSISTOR DISSIPATION, P_T: At free-air temperatures up to 25° C	180 max.	mW
above 25° C	See *Fig.1*	
FREE-AIR TEMPERATURE RANGE: Storage and Operating	-65 to +175	°C
LEAD TEMPERATURE (During soldering): At distances not closer than 1/32 inch to seating surface for 10 seconds max.	255 max.	°C

Fig.1 - Rating Chart for RCA 40235, 40236, 40237, 40238, 40239, 40240.

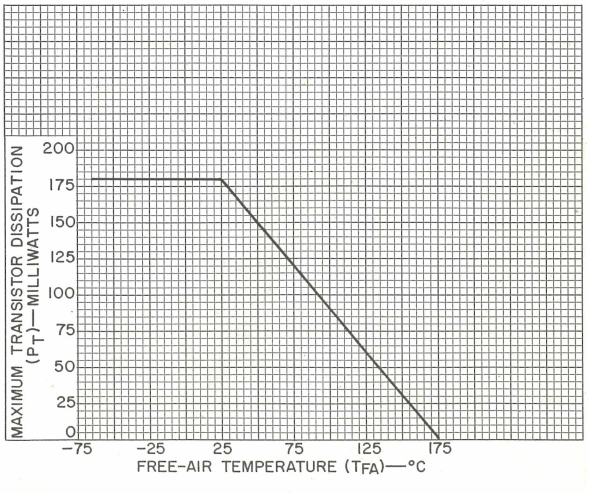
HIGH-FREQUENCY TRANSISTORS



Silicon NPN Types For TV Tuner and IF-Amplifier Applications

Features:

- high gain-bandwidth products:
  f_T = 1200 Mc/s typ. for tuner types
  900 Mc/s typ. for if-amplifier types
- very low collector-to-base feedback capacitance:
  C_{cb} = 0.5 pF typ. for amplifier and mixer types
- low cutoff currents:
  I_{CBO} = 20 nA max. at V_{CB} = 1 volt for all types
- operation to 175° C
- hermetically sealed 4-lead metal package
- all transistor electrodes electrically isolated from case
- case may be grounded by means of separate lead to minimize interlead capacitance and undesired coupling



92CS-12942

ELECTRICAL CHARACTERISTICS at $T_{FA} = 25^{\circ}$ C

CHARACTERISTICS	SYMBOLS & UNITS	LIMITS																		TEST CONDITIONS		
		40235			40236			40237			40238			40239			40240			FREQUENCY	DC COLLECTOR-TO EMITTER VOLTAGE	DC EMITTER CURRENT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	f Mc/s	V_{CE} VOLTS	I_E mA
COLLECTOR-CUTOFF CURRENT	I_{CBO} μA	-	-	0.02	-	-	0.02	-	-	0.02	-	-	0.02	-	-	0.02	-	-	0.02	-	(V_{CB}) = 1	
		-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	-	(V_{CB}) = 35	
EMITTER-CUTOFF CURRENT	I_{EBO} μA	-	-	-	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	-	(V_{EB}) = 1	
		-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(V_{EB}) = 3	
STATIC FORWARD CURRENT-TRANSFER RATIO	h_{FE}	40	-	170	40	-	275	27	-	275	40	-	170	27	-	100	27	-	275	-	6	-1
GAIN-BANDWIDTH PRODUCT	f_T Mc/s	-	1200	-	-	1200	-	-	1200	-	-	900	-	-	900	-	-	900	-	100	6	-1
COLLECTOR-TO-BASE FEEDBACK CAPACITANCE	C_{cb} pF	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	216	10	-2
		-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	216	12	-1.5
		-	-	-	-	-	-	-	-	-	-	0.5	-	-	0.5	-	-	0.5	-	216	12	-3
INPUT RESISTANCE	Ri Ω	-	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	216	10	-2
		-	-	-	-	230	-	-	-	-	-	-	-	-	-	-	-	-	-	216	12	-1.5
		-	-	-	-	-	-	-	-	-	-	480	-	-	480	-	-	480	-	45	12	-3
OUTPUT RESISTANCE	Ro KΩ	-	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	216	10	-2
		-	-	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-	-	45	12	-1.5
		-	-	-	-	-	-	-	-	-	-	35	-	-	35	-	-	35	-	45	12	-3
EXTRINSIC TRANS-CONDUCTANCE	gm mmhos	-	43.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	216	10	-2
		-	-	-	-	-	-	-	-	-	-	90	-	-	90	-	-	90	-	45	12	-3
NOISE FIGURE*	NF dB	-	3.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	216	10	-2
MAX. AVAILABLE CONVERSION GAIN	MAG_C dB	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	216 to 45	12	-1.5
OPEN-CIRCUIT COMMON BASE OUTPUT CAPACITANCE	C_{ob} pF	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	257	(V_{CB}) = 12	(I_C) = -2.5
MAX. AVAILABLE AMPLIFIER GAIN	MAG dB	-	29.1	-	-	-	-	-	-	NO. OF STAGES	-	-	-	-	-	-	-	-	-	216	10	-2
		-	-	-	-	-	-	-	-	1	45.3	-	-	45.3	-	-	45.3	-	-	45	12	-3
		-	-	-	-	-	-	-	-	2	45.3	-	-	45.3	-	-	45.3	-	-	45	12	-3
		-	-	-	-	-	-	-	-	3	45.3	-	-	45.3	-	-	45.3	-	-	45	12	-3
MAX. USABLE AMPLIFIER GAIN (UNNEUTRALIZED)	MUG dB	-	-	-	-	-	-	-	-	NO. OF STAGES	-	-	-	-	-	-	-	-	-			
		-	-	-	-	-	-	-	-	1	22.9	-	-	22.9	-	-	22.9	-	-	45	12	-3
		-	-	-	-	-	-	-	-	2	20.7	-	-	20.7	-	-	20.7	-	-	45	12	-3
		-	-	-	-	-	-	-	-	3	19	-	-	19	-	-	19	-	-	45	12	-3
MAX. USABLE AMPLIFIER GAIN (NEUTRALIZED)	MUG dB	-	18.1*	-	-	-	-	-	-	NO. OF STAGES	-	-	-	-	-	-	-	-	-	216	10	-2
		-	-	-	-	-	-	-	-	1	28	-	-	28	-	-	28	-	-	45	12	-3
		-	-	-	-	-	-	-	-	2	25.8	-	-	25.8	-	-	25.8	-	-	45	12	-3
		-	-	-	-	-	-	-	-	3	24.1	-	-	24.1	-	-	24.1	-	-	45	12	-3

* Measured in circuit shown in Fig.2.

L_1 – Tunes with 10 pF @ 216 Mc/s and has an unloaded Q of 150

Turns Ratio for Base Tap = 2.88
Turns Ratio for Input Tap = 5.36

L_2 – Tunes with 12 pF @ 216 Mc/s

Adjust the unloaded Q of L_2 to reflect 890 ohms at the collector with the 50 ohm load disconnected. Adjust C_1 so that the 50 ohm load is reflected as 775 ohms at the collector with a resultant collector load of 410 ohms.

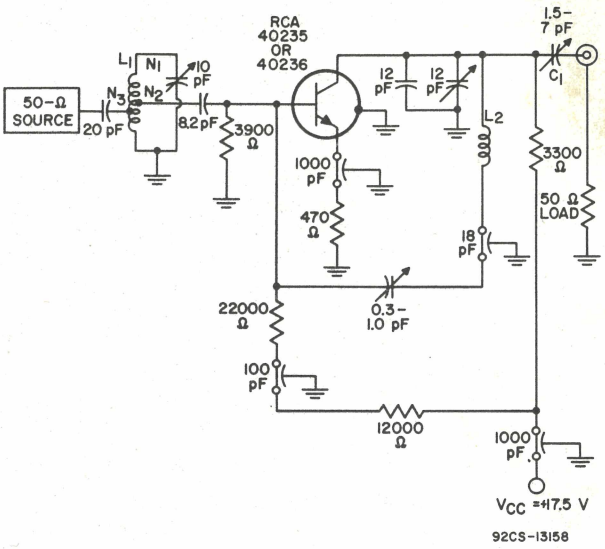
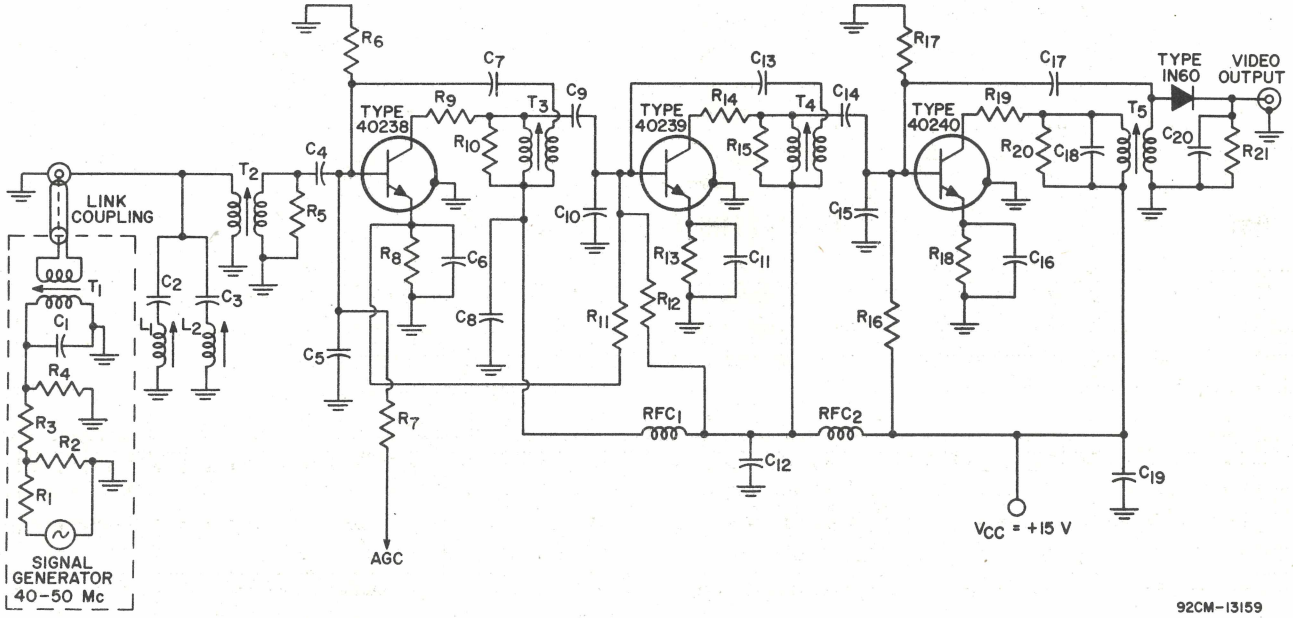


Fig.2 - 216-Mc/s Power Gain and Noise Figure Test Circuit for RCA-40235.



C_1, C_9, C_{14}, C_{20} = 10 pF
C_2, C_3 = 12 pF
C_4 = 13 pF
C_5 = 180 pF
C_6, C_8, C_{11}, C_{12}, C_{16} = 0.005 μF
C_7 = 4.7 pF
C_{10} = 56 pF
C_{13} = 6.8 pF
C_{15} = 120 pF
C_{17}, C_{18} = 1.2 pF
C_{19} = 0.01 μF
R_1, R_2 = 50 Ω
R_3 = 68,000 Ω
R_4, R_5 = 18,000 Ω
R_6, R_{12}, R_{17} = 10 Ω
R_7, R_{11}, R_{16} = 10,000 Ω
R_8, R_{13}, R_{18} = 1000 Ω
R_9, R_{14}, R_{19} = 47 Ω
R_{10}, R_{15} = 1800 Ω
R_{20} = 33 Ω
R_{21} = 4700 Ω

RFC_1 = 10 μH
RFC_2 = 10 μH

Fig.3 - Typical 3-Stage 43.5-Mc/s Amplifier Circuit.

Should be 10 kΩ ?

DESIGN DATA FOR IF TRANSFORMERS AND TRAPS SHOWN IN FIG.3

ALL COILS ARE WOUND OF FORMVAR*, OR EQUIVALENT, WIRE ON 9/32-INCH O.D. FORMS EMBOSSED OR TAPPED TO ACCOMMODATE 1/4 x 28 THREAD SLUGS, 0.375-INCH LONG, MADE OF ARNOLD# TYPE SF OR EQUIVALENT MATERIAL.

T_1/T_2: Double-tuned, overcoupled transformer ($K = 1.73\ K_C$), with link coupling
- Primary (T_1): 9 turns No.30, close-wound
- Secondary (T_2): same as primary
- Coupling link: 1 turn No.26, wound over ground end of primary

T_3: Single-tuned transformer
- Primary: 10 turns No.26, close-wound
- Secondary: 1 turn No.30, wound over ground end of primary

T_4: Single-tuned transformer
- Primary: 11 turns No.26, close-wound, tapped at 1 turn from ground end. DC collector-supply voltage is connected to tap; neutralizing capacitor (C_{13}) is connected to ground end

T_5: Single-tuned transformer
- Primary: 14 turns No.30, close-wound
- Secondary: 7 turns No.30, close-wound next to ground end of primary

L_1: 39.75-Mc/s trap
- 12 turns No.30, close-wound

L_2: 47.25-Mc/s trap
- 9 turns No.30, close-wound

* Trade Mark, Shawinidan Products Corp.
\# Arnold Magnetics Corp., Los Angeles, Calif.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended servise is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

The *flexible leads* of the 40235, 40236, 40237, 40238, 40239, and 40240 are usually soldered to the circuit elements. It is desirable in all soldering operations to provide some slack or an expansion elbow in the leads, to prevent excessive tension on the leads. It is important during the soldering operation to avoid excessive heat in order to prevent possible damage to the devices. To absorb some of the heat, grip the flexible lead of the device between the case and the soldering point with a pair of pliers.

When dip soldering is employed in the assembly of printed circuits using these devices, the temperature of the solder should not exceed 255° C for a maximum immersion period of 10 seconds. Furthermore, the leads should not be dip soldered within 0.031" of the metal case.

The devices described in this bulletin should not be connected into or disconnected from circuits with the power on because high transient currents may cause permanent damage to the devices.

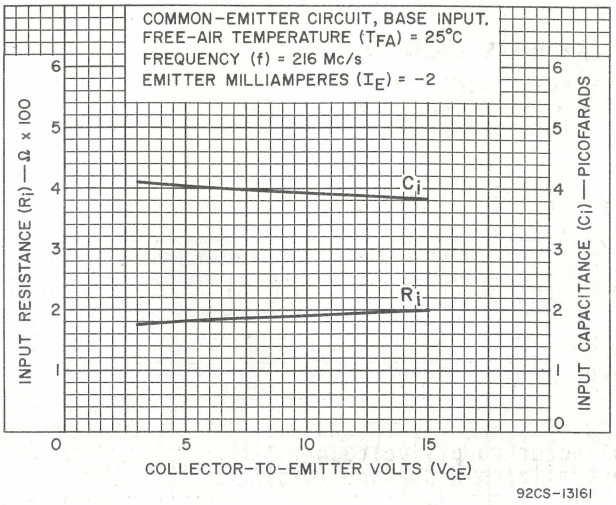


Fig.4 - Typical Input Characteristics at 216 Mc/s for RCA-40235.

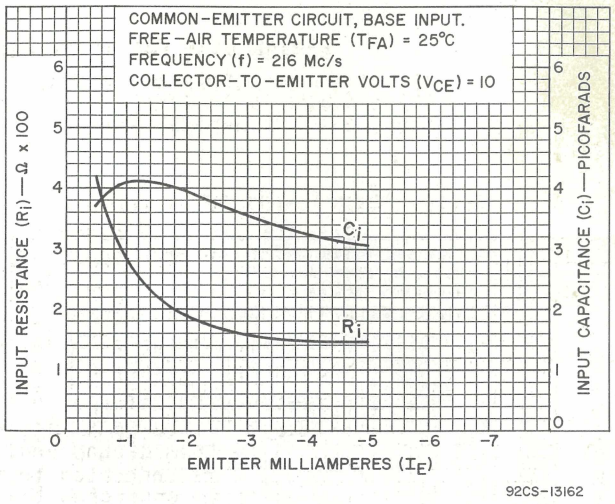


Fig.5 - Typical Input Characteristics at 216 Mc/s for RCA-40235.

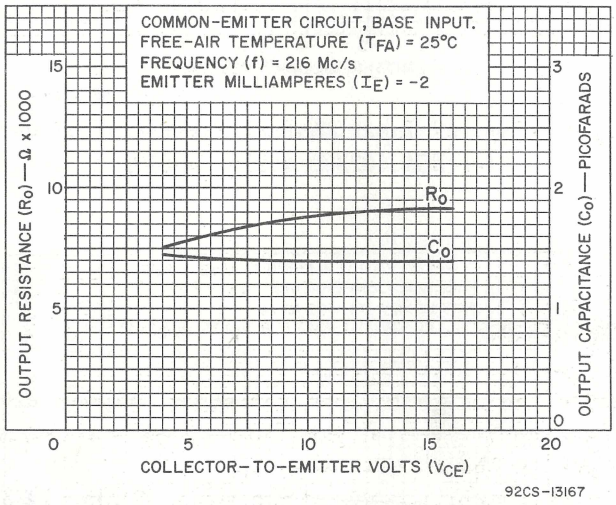


Fig.6 - Typical Output Characteristics at 216 Mc/s for RCA-40235.

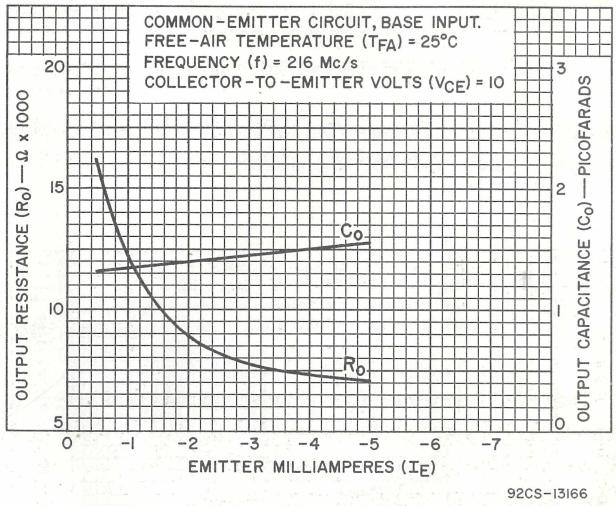


Fig.7 - Typical Output Characteristics at 216 Mc/s for RCA-40235.

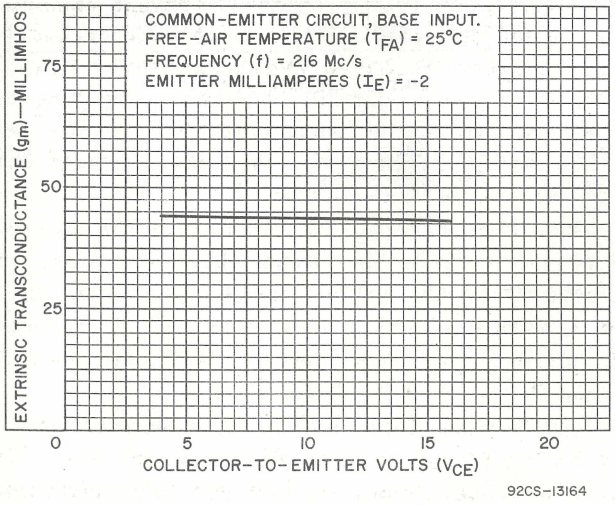

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25°C
FREQUENCY (f) = 216 Mc/s
EMITTER MILLIAMPERES (I_E) = -2
EXTRINSIC TRANSCONDUCTANCE (g_m) — MILLIMHOS
COLLECTOR-TO-EMITTER VOLTS (V_{CE})
92CS-13164

Fig.8 - Typical Extrinsic-Transconductance Characteristics at 216 Mc/s for RCA-40235.

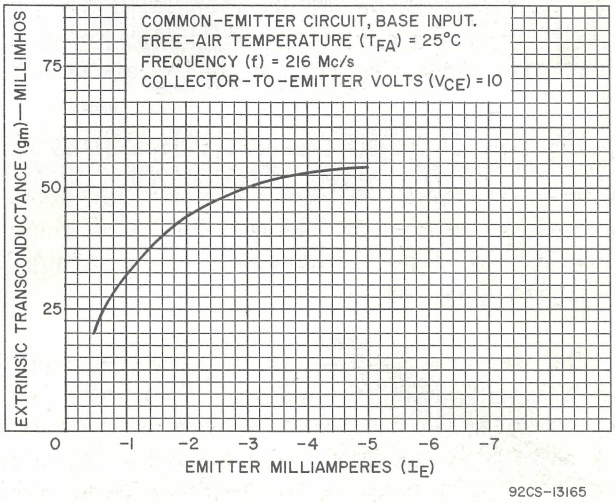

COMMON-EMITTER CIRCUIT, BASE INPUT.
FREE-AIR TEMPERATURE (T_{FA}) = 25°C
FREQUENCY (f) = 216 Mc/s
COLLECTOR-TO-EMITTER VOLTS (V_{CE}) = 10
EXTRINSIC TRANSCONDUCTANCE (g_m) — MILLIMHOS
EMITTER MILLIAMPERES (I_E)
92CS-13165

Fig.9 - Typical Extrinsic-Transconductance Characteristics at 216 Mc/s for RCA-40235.

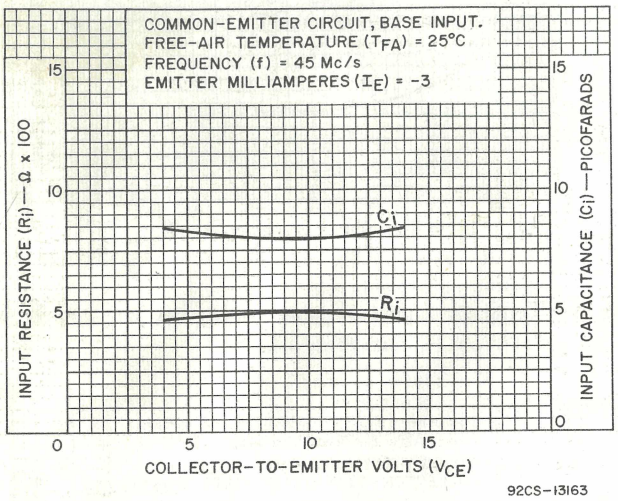


Fig.10 - Typical Input Characteristics at 45 Mc/s for RCA 40238, 40239, 40240.

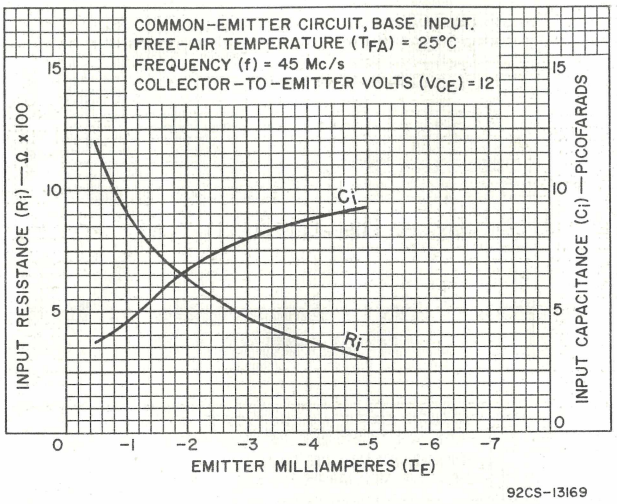


Fig.11 - Typical Input Characteristics at 45 Mc/s for RCA 40238, 40239, 40240.

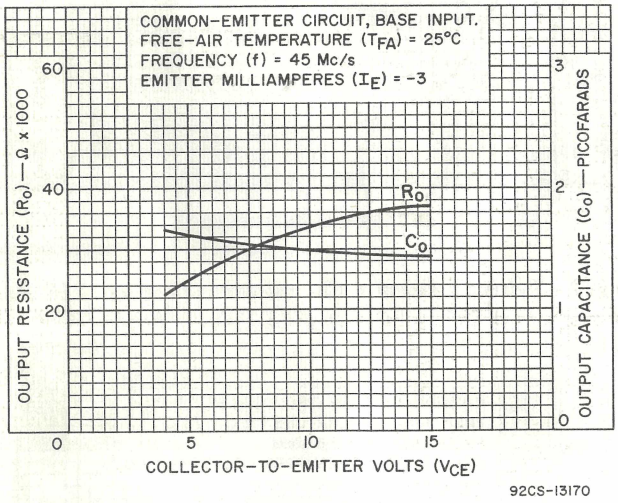


Fig.12 - Typical Output Characteristics at 45 Mc/s for RCA 40238, 40239, 40240.

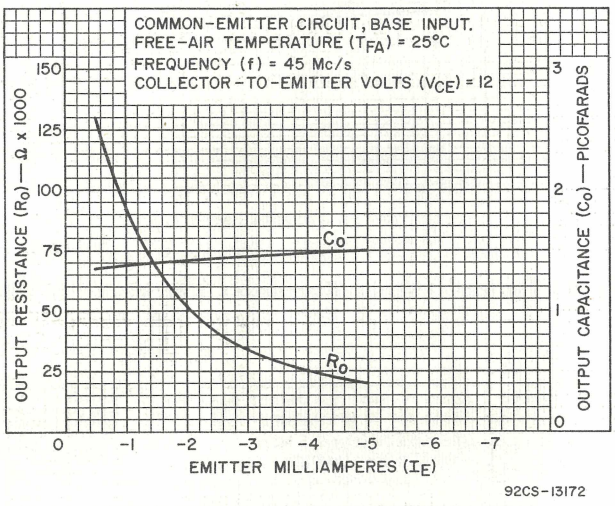


Fig.13 - Typical Output Characteristics at 45 Mc/s for RCA 40238, 40239, 40240.

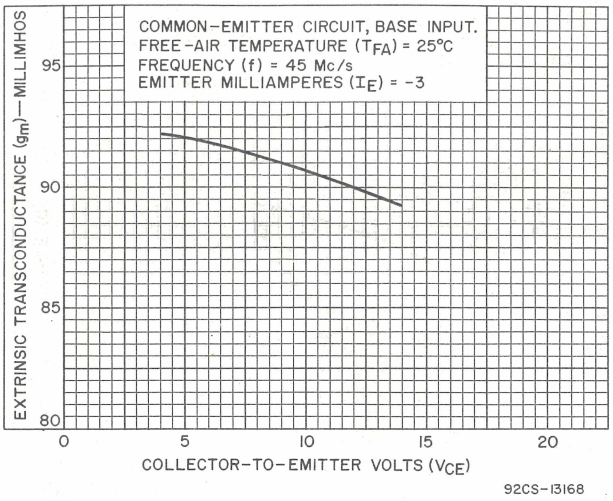


Fig.14 - Typical Extrinsic-Transconductance Characteristics at 45 Mc/s for RCA 40238, 40239, 40240.

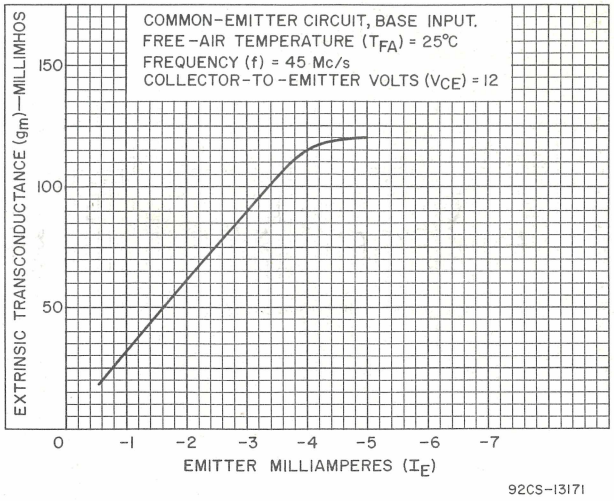


Fig.15 - Typical Extrinsic-Transconductance Characteristics at 45 Mc/s for RCA 40238, 40239, 40240.

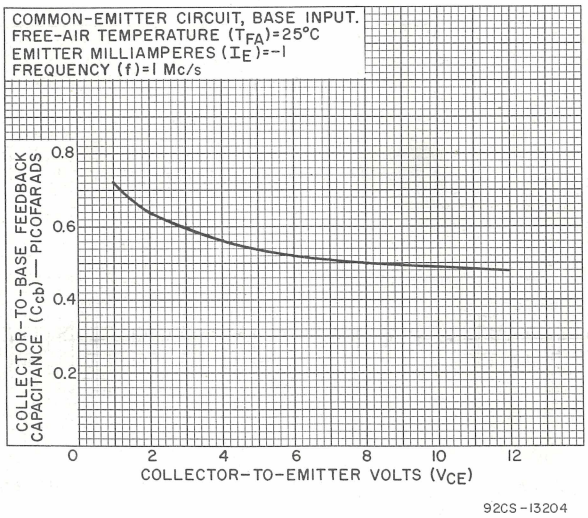


Fig.16 - Typical Feedback Capacitance Characteristics for RCA 40235, 40236, 40237, 40238, 40239, 40240.

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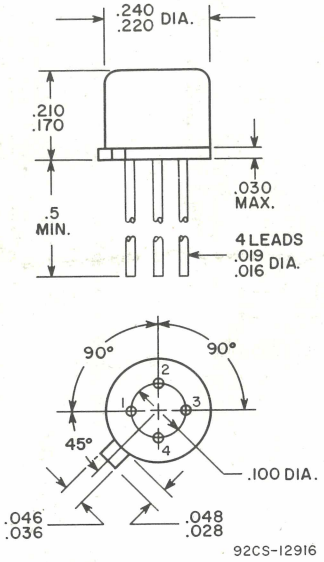
DIMENSIONAL OUTLINE

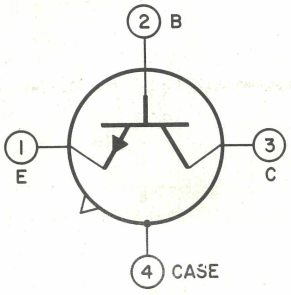
40235, 40236, 40237
40238, 40239, 40240



DIMENSIONS IN INCHES

TERMINAL DIAGRAM

Bottom View



Lead 1 – Emitter
Lead 2 – Base
Lead 3 – Collector
Lead 4 – Connected to Case

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